4.0 HFBR Tritium Plume Characterization and Mitigation

Background

In its February 1997 interim report, EH indicated a need for expedited planning, preparation, and implementation of mitigation and remediation actions to address the tritium plume. The intent of this expedited planning and implementation of plume characterization and interim remedial action was to minimize the amount of tritium contamination that could reach the southern boundary of the laboratory site.

Results

BNL has an aggressive program to mitigate the tritium plume.

BNL has implemented an aggressive, multifaceted project to address characterization of the plume and mitigation of the contamination. The program includes the following key project elements: (1) determine the profile of the plume, (2) perform groundwater sampling and analysis to support plume characterization, (3) install permanent monitoring wells to allow monitoring of plume mitigation, (4) design and implement an effective interim remedial action, and (5) identify and evaluate alternatives and then design and implement a long-term remedial action. BNL has succeeded in assembling an effective project team that has mobilized substantial resources to complete key project tasks.

Wells have been installed to help determine the extent of the contamination.

The plume characterization efforts have led to a refined interpretation of the horizontal and vertical extent of the tritium plume. The most recent plume map (Figure 4) is based on data that has been compiled to date. This map shows that the plume splits or is partitioned into an eastern and a western lobe. The southern portion of the plume is believed to split because of rainwater entering the aquifer from the recharge basins that are located on Weaver Avenue. The location of the end of each lobe is not exactly known, but existing well data have enabled a reasonable approximation of their extent. Seventy-four vertical profile wells have been installed to characterize the plume; one well remains to be installed.

In addition to determining the lateral extent of the plume, interval sampling in the network of vertical profile wells has enabled a determination of the vertical variability of tritium concentration within the plume. This information has helped to determine the correct placement of the screen intervals for the three tritium plume extraction wells. The extraction well screens have been placed in the highest concentration areas of the plume along Princeton Avenue. Sample data indicate tritium concentrations of about 5500 to 6800 pCi/L in the screened portion of the aquifer at the extraction well locations, which is significantly below the EPA drinking water limit of 20,000 pCi/L.

The nature and extent of contamination along the western side of the plume is still undergoing final characterization. Recent samples indicate that the plume may be wider and more concentrated in the area of the western lobe than was previously thought based on earlier data. Current plans call for the sampling of one more vertical profile well in this area

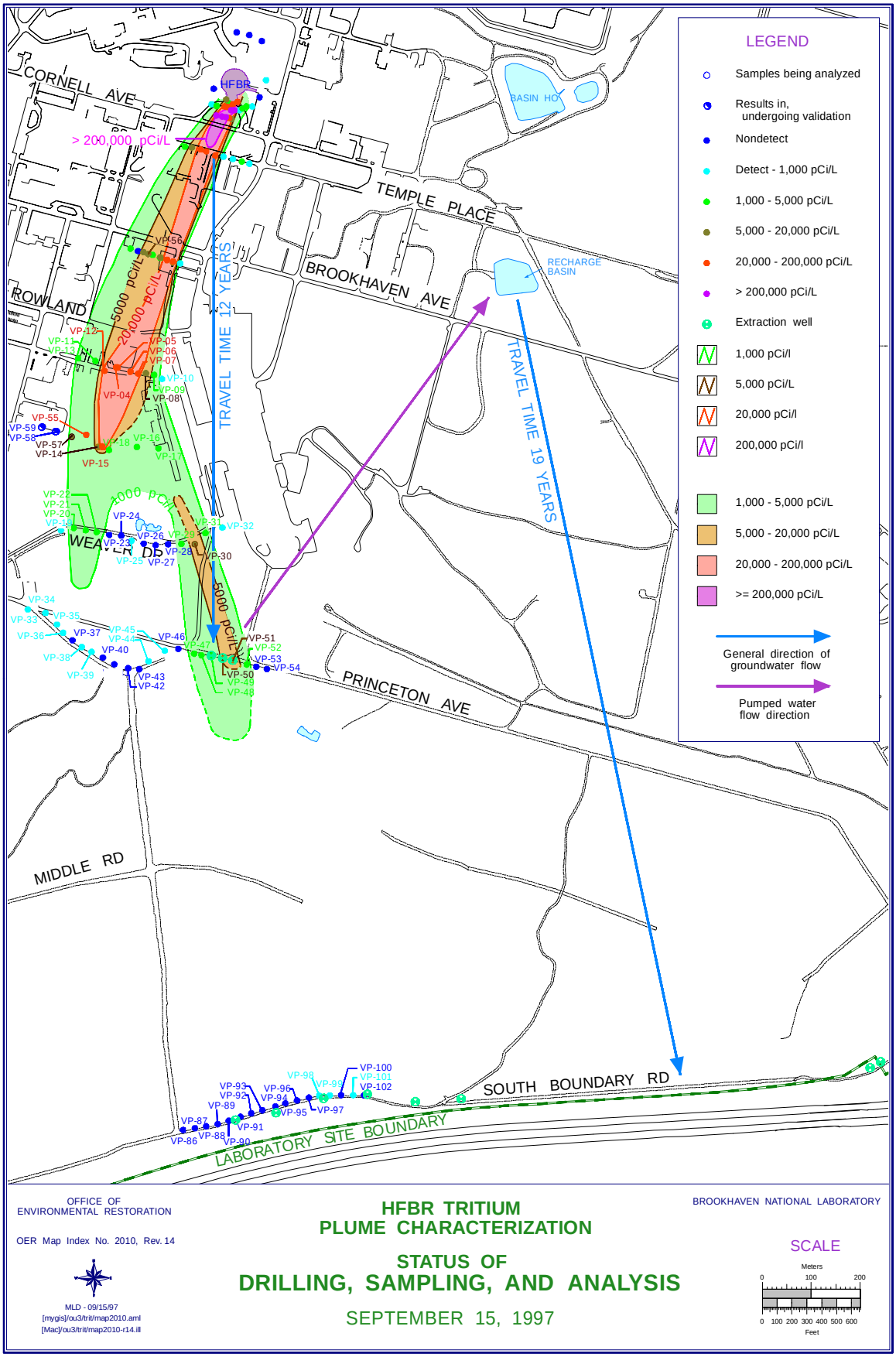

Figure 4. Map of Tritium Plume

before the three permanent monitoring wells are installed. These new wells are intended to provide the data that is needed to resolve uncertainty related to the extent of contamination in this area.

BNL continues to use the numerical groundwater flow and transport model to enhance the understanding, monitoring, forecasting, and implementation of remedial action. As of mid-August 1997, there is an ongoing effort to develop a transient model that reconstructs the history of the tritium plume from the time that the HFBR may have first released tritium into the aquifer, to the present-day plume, as it has been defined by recent vertical-profiling-based characterization. This effort involves accounting for and building into the model a series of transient hydraulic stresses that the aquifer has actually experienced due to temporary operation, over the course of the past 30 years, of various water supply wells and recharge basins in the vicinity of the HFBR. This effort is intended to provide a good understanding of how the plume was generated, and whether other potential sources may have or may still be contributing to the plume. This model will also be used to help evaluate the effectiveness of the interim and various proposed long-term remedial actions.

As of mid-August 1997, 36 of a total of 38 permanent monitoring wells have been installed. These 38 wells will be used, in conjunction with 45 pre-existing permanent wells in this area, to monitor changes in the plume as the interim groundwater extraction and recirculation system continues to operate.

BNL is using extraction wells to pump contaminated water from the plume.

Three extraction wells have been placed along Princeton Avenue to intercept the eastern lobe of the plume about 3800 feet south of the HFBR source. These wells are collectively lifting 120 gallons-per-minute of contaminated groundwater. Selection of their locations, screen intervals, and pumping rates was based on tritium concentrations delineated by vertical profile wells and by capture zone analyses performed using the groundwater flow and transport model. This has resulted in the wells being placed in the most concentrated portion of the plume; however, the extraction pumping causes dilution that lowers the pumped groundwater to less than 1500 pCi/L of tritium. BNL analysis indicates that the extraction rate is not sufficient to cause any increase in the rate of tritium migration above the rate caused by natural southward flow of the groundwater.

Volatile organic compound (VOC) concentrations are also lower than expected in the water being pumped from the extraction wells. The concentration of five of six detected VOC constituents, which are all chlorinated hydrocarbons, are all below 5 ppb. Concentration of the sixth chlorinated hydrocarbon, tetrachloroethene, is less than 50 ppb. As was the case for tritium, these lower-than-expected concentrations result from higher-than-expected dilution during pumping. This simplifies the removal of VOCs by the carbon filters prior to recirculation. The treated groundwater is entering the recharge basin free of any detectable VOC contamination. A series of monitoring wells was installed around the recharge basin that is receiving the water from the extraction wells. Samples from these monitoring wells indicate that recirculation is not significantly impacting groundwater. Modeling indicates that upon recirculation, tritium concentrations in the aquifer are below 1000 pCi/L.

The first of five planned quarterly rounds of groundwater sampling from the permanent monitoring wells is nearing completion. As of August 9, 1997, 77 of 83 wells had been sampled. Samples will be analyzed for tritium, gross alpha and beta and gamma radiation, strontium-90, and VOCs. The remaining four quarterly rounds of samples will be analyzed for tritium and VOCs only.

Long-term remediation options are being evaluated.

BNL continues to evaluate long-term remedial actions to address the tritium plume. Options being evaluated include alternative extraction and recirculation options, institutional controls, containment, detritiation, discharge, and disposal. As the plume becomes better characterized, the decisions regarding the appropriate actions to be taken with respect to long-term remedial action will become clearer.

Assessment of Plume Characterization and Mitigation

DOE and BNL are making progress toward characterizing and mitigating the plume while long-term options are evaluated.

Since the contamination was identified in January, DOE and BNL have made significant progress in characterizing and initiating remedial action for the plume. The project is evaluating the nature and extent of tritium contamination, while concurrently determining an effective and acceptable way to ensure that this contamination will not spread and impact the water supply of the local community. BNL has made progress toward comprehensive characterization of the tritium plume and has installed a large number of monitoring wells to make certain that plume advancement has ceased and that the interim remedial action is working as designed. They are also performing additional groundwater modeling and long-term remediation planning to arrive at the most effective approach to long-term remedial action.

Continued attention is needed to compare actual sample results to those predicted by modeling techniques to ensure adequate characterization of the plume. Although the plume is now fairly well understood, there is not yet direct evidence that plume migration has ceased or that the plume is being effectively captured. Current assumptions are based on predictions from groundwater modeling, analytical results from vertical profile well samples, and general knowledge about groundwater travel time in the aquifer. It will take results from at least two of the five scheduled groundwater samples to accurately characterize the plume, including the western lobe. Other aspects of plume characterization and modeling that warrant continued emphasis include the sample results and modeling techniques, the results of specific groundwater modeling or aquifer pump tests completed to support remedial actions, and the selection process for the long-term remedial action.